How Analysts Think: Navigating Uncertainty – Aspirations, Considerations and Strategies

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ABSTRACT
While there has been considerable research in understanding the process of sense making in criminal intelligence analysis as well as the formulation of arguments in the domain of law, there remain gaps in our understanding of how to move seamlessly from the fluidity of the sense making activities to the rigour of argumentation construction. This matter is complicated further with high uncertainty which accompanies sense making and which propagates through to the rigour that accompanies argumentation. This paper attempts to understand how Criminal Intelligence Analysts navigate uncertainty from fluidity to rigour constructs and outlines some of the considerations and strategies deployed by the Criminal Intelligence Analyst to reach, or increase, certainty at a given point in time during the analysis process. This paper concludes by proposing preliminary suggestions with the aim to narrow the gaps in this journey from fluidity to rigour, at least, marginally.

KEYWORDS
Uncertainty; Sense making; Security; Government and Law

INTRODUCTION

"How Analysts Think" is a series of papers aiming to enhance our understand on how Criminal Intelligence Analyst's think, with the aim to be better informed on how to design the software they use as part of their daily activities. In Wong's (2014) paper, he introduced the concepts of sense-making fluidity and rigour. This work continued with Wong and Kodagoda's (2015) paper, which describes the inference making strategies in the analytic reasoning process and how uncertainty propagates through the analysis of criminal intelligence cases. Following on from this, Gerber et al.'s (2016) paper, proposed a framework on how intuition, leap of faith and insight occurs during Criminal Intelligence analysis. The research in this paper continues with this series and investigates how Criminal Intelligence Analysts (from now on referred to as Analysts) navigate through uncertainty. Navigating uncertainty during sense making is the process by which Analysts uses their expert skills to continually identify potential sense making problems, understand how it hinders them from reaching their aspirations and taking into account the considerations which affords the undertaking for the best possible course of action.

In this paper, we describe the Analysts' aspirations, considerations and objectives for each of the corresponding strategies employed during analysis to reach points of certainty. These points of certainty serve as possible anchoring points, which afford traction for further analysis or the launch of new lines of enquiry. Lines of enquiry can be described as facts or assertions, which are actively being pursued by Analysts or investigative officers to gain clarity on the level of truthfulness and are described as being, "specific to key facts on an investigation" (Cook *et al.*, 2013). A qualitative study using transcripts from five Criminal Intelligence Analysts reveals the problems that hinder their sense-making efforts during a variety of analytical tasks and the strategies used to resolve each. These problems relate to their mental efforts as well as the environment in which they work. Each problem hinders the Analysts' aspirations and the inverse of each problem could potentially reveal details on what those aspirations are. By studying the relationship between the strategy used and the attained aspiration, the potential considerations that have to take place before deploying the appropriate strategy are revealed. Similarly, the relationship between the aspiration, consideration and strategy reveals the potential objectives that serve as a tool to judge the level of certainty surrounding each outcome. This reveals the compound nature of certainty as a collection of multiple influential factors, which are expressed in this paper as eleven distinct aspirations. Due to space limitations, we are only able to cover three of the eleven aspirations and they are: certainty, believability and plausibility. The next section briefly outlines some of the relevant literature that inspired this research.

LITERATURE

At the onset of a case, Analysts seldom have adequate information they require to reach a conclusion. Instead, they rely on analytical, inference and sense making processes to guide them through the uncertainties

they face. Pirolli and Card's (2005) Notional Model of Analytical Sense Making provided researchers with a model, clearly illustrating the complexities of the processes involved to move from raw data to presenting a conclusion to the decision makers. Wong (2014) describes similar complexities, but concentrates on the type of thinking required by Analysts as they move from the fluid to the rigour stages of sense making. According to Wong (2014), in the fluidity phase of the sense-making activities, the stories that the Analysts construct are based on a loose assembly of data with many uncertainties and the commitment to follow through on outcomes are low. In this phase, Analysts would rely on creative thinking methods, which in turn, could leverage them into being able to generate ideas or develop a better understanding of the situation or problem and thus gain traction to progress the investigation. As the Analysts gain better understanding of the investigation in the form of new ideas or evidence, the Analysts enter the rigour stage of the sense-making process, where certainty is high and the commitment to follow through with outcomes are also high. This process is not linear and can be chaotic and cyclical, depending on the available data, goals to satisfy (e.g. to gain traction or to prove), the desired claims to be made, and their experience and/or state of knowing at that time. Wong and Kodagoda (2015) further investigated how the analytical inferencing process could invite uncertainties to propagate from one conclusion to another, thus illustrating that the final outcome should not only be tested against weak evidential sources, but also of instances where inference propagation took place.

Klein et al. (2007) suggested that the sense-making process of gaining traction involves the use of anchors and defined anchors as, "key data elements that serve to create understandings that guide subsequent inquiry". Wong and Kodagoda (2015) added to this definition by stating that they believe that "data elements can also be non-data, such as suppositions where no data exists or is ambiguous as is often the case in intelligence analysis, and are used for the purpose of gaining traction." They further elaborated this concept by stating that anchoring is the, "process of using anchors to create and evolve understanding". From the perspective of the legal domain, Wagenaar et al. (1993, p39) refer to the concept of anchors in their anchored narrative model as; "ordering the evidence in such a way that it forms anchors between the story and the ground of accepted common-sense rules". They then continue by saying that, "all critical episodes in the story need to be anchored through evidence". Bex and Verheij (2013) built upon Waggenaar et al.'s concepts and subsequently created a Hybrid theory and explain that, "facts are organised into multiple hypothetical stories, coherent accounts of what might have happened in the case. Arguments based on evidence can then be used to justify these stories, as these arguments can be used to support elements in a story with evidence or, in other words, to anchor the story in evidence (cf. Wagenaar et al. 1993)". Therefore, the sense making domain concentrates on finding traction using data and non-data elements as anchors and the law domain concentrates on an argumentation approach, which requires the justification for the interpretations of derived facts. When these interpretations are grounded in evidence or common sense rules, then those interpretations are considered strong anchors. The distinction between the use of the term anchor in the domain of sense making and law are complementary and necessary as it may reduce confusion when the same term is used in different contexts.

The Analysts' conclusions should adhere to the highest degree of certainty. Any unresolved issues or doubtful conclusions could undermine the prosecutor's case during court proceedings. This is outlined in the Association of Chief Police officers (ACPO) Core Investigative Doctrine as, "Hypotheses that are formed from limited or uncertain information can, at best, only amount to an assumption of what may have occurred and this could be influenced by personal bias or stereotyping" (ACPO, 2005). It is therefore of interest to understand which sense making problems can hinder Analysts from reaching outcomes of the highest possible degree of certainty, especially if those outcomes are used as sense-making anchors to gain traction or to launch new lines of enquiry.

The next section outlines the research conducted and what the results revealed for answering RQ1 – RQ5.

METHODOLOGY

In this paper, we report on the analysis of transcripts from Cognitive Task Analysis (CTA) interviews with five experienced Operational Criminal Intelligence Analysts. The interviewers, using the Critical Decision Method (Klein et al., 1986), investigated the inference and sense making processes of the Operational Criminal Intelligence Analyst participants from different police forces in the UK and Belgium. The interviewers wanted to understand how each Analyst resolved a particularly memorable case. Participants are more able to recall the details associated with a memorable case and the influencing factors it had, than just an ordinary case. Volume crime and serious crimes are two types of case classification that Analysts work with. The National Policing Improvement Agency (NPIA) within the Volume Crime Management Model (VCMM) defines volume crime as, "any crime which, through its sheer volume has a significant impact on the community and the ability of the local police to tackle it. Volume crime often includes priority crimes such as street robbery, burglary and vehicle-related criminality, but can also apply to criminal damages or assaults" (College of Policing, 2009). The Police Act of 1997 define serious crime as, "(Section 93.4a) [the crime] involves the use of violence, results in substantial financial gain or is conduct by a large number of persons in pursuit of a common purpose or (Section 93.4b) the offence or one of the offences is an offence for which a person who has attained the age of twenty-one and has no previous convictions could reasonably be expected to be sentenced to imprisonment for a term of three years or more " (Legislation.gov.uk, 1997). The National Intelligence Model (NIM) defines the aim of

crime analysis as, "to interpret a range of information to develop inferences, which are conclusions about what is known or what is believed to be happening" (Centrix, 2007). A third party anonymised, transcribed and reviewed the transcripts due to the sensitivity of the contents it contained. A third researcher performed the data analysis on five of the transcripts from the CTA interviews.

Crandall et al. (2006) outline the typical phases of data analysis of CTA interviews to be: preparation, data structuring, discovering meanings and representing findings. Their recommendation is to make multiple passes through the data in order to gain the most out of the richness and complexity of the data set. The first pass through our data set was to answer RQ1 and RQ2. By using the Open Coding technique as part of Grounded Theory (Corbin and Strauss, 1990), we used "problem" and "strategy" as high-level codes to identify each in the available transcripts. The results underwent re-analysis in order to sort them thematically into groups based on their characteristics. The members of each group were re-analysed and compared with other group members to insure correct assignment. When members were misplaced, we moved them into more appropriate groups. This process reiterated until saturation. This resulted in eleven distinct groups namely, Uncertainty, Skeptisism, Suspiciousness, Complexity, Obscurity, Disparity, Gaps, Misconceptions, Exhausted Options; Errors (Data Quality) and Mental Blocks. Table1 outlines each of the identified problems with their corresponding strategies and they relate to both the Analysts' mental efforts as well as the environment in which they work. After determining the results for RQ1 and RQ2, we realised that further questions remained and we added RQ3 and RQ4 to determine why and how Analysts applied particular strategies. We used the results from RQ1 and RQ2 for the analysis of RQ3 and RQ4. Our final question (RQ5) was to determine if and how it would be possible for Analysts to verify that a sense-making problem has been successfully resolved, so we used the findings from RQ1-RQ4 to achieve this.

The next section outlines the eleven different sense-making problems we uncovered in our analysis. Due to space constraints, we chose to elaborate on what we consider as three significant problems for Analysts.

RESULTS

This research attempts to answer the following five research questions: **RQ1:** What are the problems that hinder sense making? **RQ2:** Which strategies do Analysts use to overcome each problem? **RQ3:** Why do Analysts apply specific strategies? **RQ4:** How do Analysts know which strategy to apply? **RQ5:** How could the Analyst judge if a strategy resolved a particular problem? Below is a summary of the findings for each question.

RQ1: What are the problems that hinder sense making? The research identified Uncertainty, Skeptisism, Suspiciousness, Complexity, Obscurity, Disparity, Gaps, Errors, Misconceptions, Exhausted Options and Mental Blocks, as possible problems that could hinder sense making.

RQ2: Which strategies do Analysts use to overcome each problem? The research identified that for problems in uncertainty, skeptisism and suspiciousness, could be overcome by using the following strategies : Resolving ambiguity/doubt; Establishing certainty points ; Strengthening the evidence ; Strengthening their reasoning process; Considering alternatives; Increasing the understanding of outcomes; Increasing the confidence in processes; Questioning the facts; Questioning system outputs; Using simplistic two-way tests to resolve anomalies; Merging multiple confirmations into one concept.

RQ3: Why do Analysts apply specific strategies? To answer this question, the researchers revised each problem and it became apparent that the inverse of each problem represents Analysts' aspirations. This revealed that the selection process for using a particular strategy was influended by Analysts' aspirations at various moments during the analysis. The identified aspirations are: Certainty, Believability, Plausibility, Simplicity, Clarity, Creativity, Connectivity, Identifying New Possibilities; Identifying Meaning/Information; Determining Correctness (Data Quality); and Increasing Understanding.

RQ4: How do Analysts know which strategy to apply? To answer this question, the researchers investigated the relationship between the aspiration (RQ3) and the deployed strategy (RQ2) and inferred the considerations the Analysts may have had which allowed them to narrow down their choices. The considerations for certainty, believability and plausibility are expressed as questions and they are summarised in Table 2.

RQ5: How could the Analyst judge if a strategy resolved a particular problem? To answer this question, the researchers investigated the relationship between the aspirations (RQ3), considerations (RQ4) and strategies (RQ2) and outlined potential objectives that could serve as a method to judge if a particular problem has been successfully resolved. The objectives for certainty, believability and plausibility are summarised in Table 2.

The next section describes the aspirations: certainty, believability and plausibility in detail.

Certainty, Believability and Plausibility

This section discusses the research results in more detail for the Analysts' aspirations of certainty, believability and plausibility. Table 2 offers a summary of these results. The explanations below outline the meaning of the Analysts' aspirations and the strategies employed to reach each of the aspirations.

Each of the strategies are then explained and start off with what Analysts could have considered at that moment in time in the analysis phase, given the data that was available. This is followed with the relevant interview extracts. Interview extracts are in italics and follow the format of the participant number, the relevant

lines in the interview and finally the interview extract. Extracts have been desensitised to be gender and location neutral, due to the sensitivity of the data set.

Table 1 – Summary of the research results for RQ1, RQ2 and RQ3

#	Problem (RQ1)	Aspiration (RQ3)	Context of Example	Example	Example of a strategy used to reach the aspiration (RQ2)
1	Uncertainty	Certainty	Modus Operandi (MO) Details	(P2:267-275) "...I couldn't do anything because we had nothing to go on further, only a car and a figurative name... could be an anagram…The phone… they can see where they are living and then can go and look in the neighbourhood if a name occurs over there..."	Task officers to ask for the information within the neighbourhoods
2	Skeptisism	Believability	Findings during analysis	(P3:488-490) "...Whether [colleague] could see anything different to me or just what I can see, reassurance that checking that [colleague] agrees, seeing if there's anything... different that s/he would look at..."	Talk to other colleagues to confirm analysis/findings
3	Suspiciousness	Plausibility	Hotspots on a map	(P3:353-354) "...Shopping centres and things like that will show higher than the things that you actually want..."	Question how plausible it is for a hotspot to be significant on a specific region on a map
4	Complexity	Simplicity	Starting a case	(P12:2) "...What do we know about this one? We are checking everything…police reports.., everything…this we don't know… this is a probability… this is unknown… and now we know exactly what is what…at that time we set it all out…"	Structuring information into manageable pieces
5	Obscurity	Clarity	Too much data	(P1.353-355) "...I just ask my database how many times he has been there…Day minus one, day minus two, day minus three…"	Comparisons between data sections
6	Disparity	Connectivity	Unknown relationships	(P12:36) "...We need to know if it is a series... If it is an organisation behind it..."	Create relationships to other data points
7	Mental Blocks	Creativity	Unable to resolve the problem at hand	(P3:184-185) "...we do go out and see what the areas are like where the offending is happening..."	Use creative methods to see the situation with fresh eyes
8	Exhausted Options	Finding New Possibilities	Normal solutions does not fit the problem	(P3:157-158) "...Look at a few different places that weren't necessarily that close, but there might be arterial routes if the offenders where using cars..."	Increase the scope of the analysis
9	Gaps	Finding Meaning / Information	Too many gaps in the data to identify offenders	(P6:83-86) "...Where we're having smash and grabs, that's people smashing the windows, just highlighting to officers…stop and search people within the area, see what tools they've got on them that would be useful to break a window..."	Enrich the available data with new information
10	Errors (Data Quality)	Determining Correctness (Data Quality)	Data errors	(P6:442-443) "...The issue I had with offender B was there were too, there was files created for him/her so all of his/her information was split over different links..."	Verify and correct data errors
11	Misconception	Increasing Understanding	Information does not conform to the Analysts mental model of the crime	(P1:185-191) "...I need to know more about the [parent] and I ask the detective squad about the [parent]…"	Talk to other colleagues to obtain more information when an offender's behaviour is not as expected

Certainty

Certainty refers to the degree of correctness or truth. This is more easily described in terms of physical properties or scientific results. These are things that Analysts can easily determine as it is available in front of them – in black and white so to speak. An example is: It is certain that the time of death is 9pm, as it is the time that the officer reported shooting the offender in self-defence. Certainties most likely would require to be underpinned by data. This in turn requires good quality and reliable data. Certainty refers to both the data as well as the Analyst's mental state. The strategies employed by Analysts to increase the certainty were through the actions of: (1) Resolving ambiguity/doubt, (2) Establishing certainty points and (3) Strenghtening the evidence. The section below discusses each strategy in more detail.

(1) Resolve ambiguity / doubt: One of the strategies that Analysts can employ to increase certainty, is to resolve ambiguity in the data in order to ensure that Analysts knows exactly who or what they are working with. In this example the Analyst is unsure if the name in the crime report is an anagram or if the offender uses his/her real name. To increase certainty on this matter, the Analyst asked the officers to confirm the details in the offender's neighbourhood and thus lends to resolving the ambiguity. *(P2:267-275)"...I couldn't do anything because*

we had nothing to go on further, only a car and a figurative name... could be an anagram…The phone… they can see where they are living and then can go and look in the neighbourhood if a name occurs over there..."

(2) Establishing certainty points: In some cases, there is either too little or too much data and the Analyst is required to focus on a particular entity, which offers the most certain information from which to gain traction. In this example the Analyst uses the phone found on the victim, who in this case is also a known offender, as a starting point to establish the identities of the other possible offenders by looking at the previous calls made. *(P12:15)"…And you might see that there aren't any communications going out anymore… because s/he is dead… if there is incoming, okay that is good…but, I have to establish what happened here… if there is no more outgoing communications and the phone was found in his/her pocket then I say... the phone belongs to him/her...at this point in time..."*

(3) Stengthening the evidence: The Analyst can go one step further (from the outlined point under number 2) and strengthen the certainty by resolving the remaining doubt on whether or not the phone does belong to the victim, by cross-checking the phone's location with the location in which the victim lives. In doing so, the Analyst has successfully created a certainty point from which to drive the investigation with enough evidence to support his/her conclusion. *(P12:16)"…What I also do is find out where does s/he live... If s/he is not illegal, then s/he has a house...and every house (belongs) a telephone mast...and if I say that most of the communications from that mast is in the morning and evenings... Then I can say that s/he lives there..."*

Table 2 - Summary of the research results for RQ1-5 for the Analysts' apirations of: certainty, believability and plausibility

Problem (RQ1)	**Aspiration (RQ3)**	**Consideration (RQ4)**	**Objective (RQ5)**	**Strategies Deployed (RQ2)**
Uncertainty	Certainty	How certain am I that the data is clear to me and that I understand what I see or read?	Demonstrate understanding and data clarity	Resolve ambiguity/doubt
		Which details are the most certain at this point in time, that I can use to progress my case?	Differentiate between what is certain and uncertain	Establish certainty points
		How can I increase the certainty of particular findings/details?	Demonstrate highest certainty level of findings/details	Strengthening the evidence
Skeptisism	Believability	How believable is it that the findings/analysis is correct or showing what I think it is showing?	Demonstrate a verified reasoning process	Strengthening the reasoning process
		How believable is it that the current approach is correct or alternatives could be playing a role?	Demonstrate a verified approach	Consider alternatives
		How believable is it that the current nominal is involved based on the data that points to this nominal?	Demonstrate verified outcomes	Increase understanding of outcomes
		How believable are the documents / analysis / findings that are being handed down from one person to another?	Demonstrate a verified process	Increase confidence in processes
Suspiciousness	Plausibility	How plausible is it that the current nominal is the offender and that the evidence is not super-imposed?	Demonstrate impartiality	Questioning the facts
		Is it plausible that the system is giving me false positives given this information?	Demonstrate objectivity	Questioning system outputs
		What is the most plausible option given the current anomaly?	Demonstrate decision making and choices	Use simplistic two-way tests to resolve anomalies
		How plausible is it that different people/objects/elements in different places are actually the same thing?	Demonstrate confirmations obtained	Merge multiple confirmations into one concept

Believability

Believability is the likelihood of something being true. It can be believable that offenders re-offend in Local Police Units (LPUs) after being released from prison. Is that a certainty? No, because it is not true for all offenders and other factors might also play a role, such as offenders migrating between LPUs. These instances are most likely underpinned by Analysts' general beliefs, domain and/or personal experiences. This in turn requires verification through further analysis or confirmation from external sources such as the police officers patrolling the streets. Believability refers to both the data as well as the Analyst's mental state. The strategies employed by Analysts to question the believability were through the actions of: (1) Seeking reassurance, (2) Considering alternatives, (3) Increasing their understanding on a particular topic and (4) Increasing their confidence level of the work they produced. The section below explains each strategy in more detail.

(1) Seeking Reassurance: The Analysts can reassure themselves that their reasoning is valid, by reducing any doubt they have in respect to their own capabilities as well as the data. This was achieved through increasing their confidence in the believability of their findings as well as confirming assumptions about data. Both routes involved the gathering of additional information, but were accomplished through different strategies. **(1a)** To reassure themselves of the believability of their findings, the Analysts

brainstormed with other colleagues to get their point of view on the subject and thus strengthened their own reasoning and beliefs. This in turn increases the overall certainty of the analysis performed. *(P3:488-490)"...whether [colleague] could see anything different to me or just what I can see, reassurance that checking that [colleague] agrees, seeing if there is anything... different that [colleague] would look at…"* **(1b)** To confirm assumptions made on the data, the Analysts used a probing activity by tasking officers to keep an eye out for particular details and to report back on their findings. Therefore, Analysts may believe that something is pointing to an offender, but they do not have the evidence to prove it. So although believable, it is not certain. *(P6:361-367)"…Here's the intelligence we need [officer] to gather, here are offenders we specifically want [officer] to look at because they are who we think might be doing it – we've got the evidence pointing that way, intelligence as to say, pointing that way, but there's nothing concrete..."*

(2) Considering Alternatives: The Analysts will try to increase the believability of their work through considering alternative pathways (possibilities or explanations) thus clarifying any assumptions they may have about the data. The question here is if it is believable that the offenders could travel between hotspots. The Analyst can achieve this by testing the probability of the assumption being possible. This is achieved through an internal questioning process which allows them to build a likely profile of an offender and/or the location. *(P6:381-386)"…I looked at what crime they'd been arrested for and then looked at what, where that crime took place, if any took place within the location or – 'cause there was only one within, near my hotspot, I then think oh, maybe it's not too difficult for them to go here to there…or were any of these crimes a very similar MO for a specific MO that I was looking at..."*

(3) Increasing Understanding: Nominal is a term used by UK Police to refer to a person who is a witness, suspect, offender or a victim. Analysts could try to increase the believability of a nominal as an offender, by increasing their understanding of the circumstances surrounding that nominal. This is accomplished by expanding their horizon by branching out and asking alternative questions. This could result in more information and thus a deeper understanding of the nominal and their actions within a particular scenario. This questioning process is performed as part of an internal dialogue and will not necessarily be externalised. *(P1:396-397)"…Every move he made… Every communication… Why him?…"*

(4) Increasing Confidence: The Analysts are not necessarily the first to analyse the data. They may have doubts about how exhaustively prior work has been completed, i.e. no stone was left unturned. The Analysts do this by questioning the validity of what they observe by double checking the documents / processes. *(P6:159-168)"…I want to know what the officer's done already, if s/he's, you've looked at the pattern and if you've done exactly what it's found to do then you can do it again, or if I don't believe you've done it thoroughly enough I'll do it again. Erm, I need to know what you've done, so I went through, checking to see have they, [System Searched] him, have they found, erm, because I mean looking, it was looking through these notes that I found out that they hadn't got the property from him/her – so I didn't know that before, it didn't state that in the MO…"*

Plausibility

Plausibility is the degree to which something makes sense. It is believable that offenders re-offend in a LPU, but is it plausible that offender A could travel to all three locations in under half an hour? These instances are most likely underpinned by the reasoning capabilities of Analysts based on the extent of their knowledge of the how the world works and especially their domain. Plausibility refers to how much the information or analysis conducted makes sense. The strategies employed by Analysts to judge the plausibility of a situation were: (1) Questioning the facts, (2) Questioning system outputs, (3) Using simplictic two-way tests to resolve anomalies and (4) Merging multiple confirmations into one concept. The sections below explain each strategy in more detail.

(1) Questioning the facts: Analysts ensures that the investigation is based on the available facts and that an offender is not wrongly acused of a crime based on previous convictions. Although the Analysts may already have knowledge of the offender's previous offences, which makes it plausible that the offender is involved again, Analysts must consider the information in front of them and not superimpose their beliefs on the offender. *(P6:266-280)"...stereotyping ... I mean they are innocent until proven guilty so we can't just start looking – er, well, you always do it so it's your fault, so I'm just gonna put everything on you or find stuff to prove that it's you, I need to come from an unbiased point of view... previous offending can't count at all – it does in terms of my thought process but it doesn't in terms of my analysis, I'm still gonna take the exact same analysis regardless of – this offender I've never heard of, but even if I had I'd be doing exactly the same things in a way to make sure I've not superimposed him/her in that position as opposed to him/her actually being there..."*

(2) Questioning System Output: The Analyst is unsure if the visualisation is actually producing the correct presentation. The visualisations are driven by the underlying data which can produce false positives. In these cases the Analyst is required to question the plausibility of outputs and consider factors which could be influencing the outputs. *(P3:353-354)"...Shopping centres and things like that will show higher than the things that you actually want..."*

(3) Using simplistic two-way tests to resolve anomalies: To more quickly progress the analysis, the Analyst creates a two-way test to judge which option is more plausible given the current anomaly as presented in the data. The path which is most plausible can be followed first in the anlaysis. In the example **(1a),** it is more plausible that one offender is being driven to the crime location, than not. *(P12:25)"…I see him communicating with this number... driving to this phone mast...the communication stops...gap...so hypothesis... He is calling him to say that I am going to fetch you or not…"* Example **(1b)** is testing the involvement of an offender given the data. In this instance

the Analyst judges the plausibility of the offender being involved based on his/her behaviour moments after the offence took place. Given the data that the offender called his/her spouse to possibly inform what had happened and that he/she is required to go silent (lay low) for a while, increases the plausibility that the offender had something to do with the event, than not. *(P12:29)"...Hypothesis... Is this (P)...probably as the phone mast covers the whole region of (P)... The communication with the [spouse] and then the silence after the event..."*

(4) Merging multiple confirmation into one concept: The Analyst can combine data based on the plausibility that it is the same object, appearing in different contexts. *(P12:33)"...When I have two or three confirmations that the number is (P), then I'll merge them..."*

Plausibility and Believability can work with each other or against each other. When working with each other it could move the Analyst towards clarity and understanding and eventually towards certainty. When working against each other it creates contradictions. The next section discusses the implications of the research findings and how it could influence design considerations for applications in sense making for Criminal Intelligence Analysis.

DISCUSSION AND CONCLUSION

This research identified eleven aspirations that can influence the collective level of certainty surrounding the outcomes of analytical sense-making activities. This paper outlined three of those aspirations in detail. The results section outlined various components, which could be present during a typical analytical sense-making activity. As sense-making problems surface during the analytical process, they present the Analyst with sense-making blockages, which increase the collective level of uncertainty. These blockages hinder Analysts from moving from where they currently are to where they want to be - which is to be on a more certain foothold. To work through a particular sense-making problem, the Analyst could use various *strategies*. During the sense-making activity, Analysts do not apply the strategies randomly, but uses their current *aspirations* to select the best one. Each aspiration reveals the current mind set of Analysts, indicating what they are striving for, but cannot reach until they have overcome the problem. When reached, each aspiration adds to the collective level of certainty. In order to apply the appropriate strategy, Analysts have various *considerations*, which they need to address. These considerations could be in the form of questions, which Analysts could ask internally when faced with a problem. This should subsequently point them in the right direction on which strategy to apply. A corresponding objective can serve Analysts with a method to judge if the problem has actually been successfully resolved, given the outcomes.

In navigating uncertainty, Analysts use their expert skills to continually identify potential sense-making problems, understand how they hinder them from reaching their aspirations and take into account the considerations which affords the undertaking for the best possible course of action.

By considering why each strategy was applied (as to only which ones exist), we are able to differentiate between the multitude of factors that influence certainty (in its collective form) during sense-making activities. This differentiation may be important when designing software for assisting sense making in Criminal Intelligence Analysis, as it may allow for additional sense-making affordances. If it is possible for an Analyst to be aware of the changing levels of certainty within current analytical activities, along with the influx of additional information, then it could serve as reflectors marking the way through a given task, as and when the Analyst is performing it. This affords similar functionality to cat's eye reflectors marking a road for a motorist during poor visibility, affording them the ability to navigate safely.

One possible way to achieve this is by borrowing the concepts of perspectives (Bex and Verheij, 2013) from the law domain and by introducing a new certainty perspective, which outlines the certainty levels for each different type of aspiration as per the considerations made at each stage. The objectives accompanying each consideration and matching strategy can serve as a method to judge the level of certainty. Rigid argumentation structures may force Analysts to use all of the outcomes if used from the onset, so a low-commitment option may be more desirable which is what a certainty perspective could offer. Analysts would then have a way to judge the most certain outcomes, at that point in time during the analysis, allowing them to effectively progress their lines of enquiry without over committing to the outcomes. Using the certainty levels to judge "proven" outcomes could allow for more effective argumentation using a factual perspective during the rigour stages of sense making.

Further research is required to establish if the certainty perspective can be reached from the onset or if addditional perspectives are required (illustrated by a question mark in Figure 1). Figure 1 depicts the roles of perspectives in their respective areas. Factual and Legal Consequences perspectives form part of the rigour part of sense making in the legal domain where the facts or consequences are known and the commitment to use in an argumentation structure or schema is high. A certainty perspective has varying levels of certainty and these certainty levels could evolve over time as the Analyst discovers new information. It therefore requires the Analysts to have low commitment to outcomes as

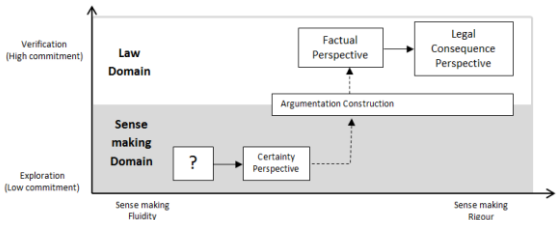

Figure 1 - Depiction of the different perspectives and how they could relate between domains

they are still in the exploration stage of the analysis.

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